

REDISCOVERY OF *SOLANUM INCOMPLETUM* DUNAL (SOLANACEAE) ON THE U.S. ARMY'S POHAKULOLOA TRAINING AREA, HAWAII

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ABSTRACT

A federally endangered plant species, *Solanum incompletum* Dunal, was "rediscovered" on the U.S.-Army's Pohakuloa Training Area, Hawaii. On 19 January 1996, nine adults and two seedlings of *S. incompletum* were found growing in a *Myoporus sandwicense* A. Gray dominated shrubland at an elevation of approximately 1425 m. Consumption by feral ungulates (sheep and/or goats) is the major threat to the continued existence of this population, and each adult plant had been severely browsed. The location of the population on a nearly inaccessible margin of the installation makes impact by military activities highly unlikely.

KEY WORDS: *Solanum*, Hawaii, endangered species, extinction

The U.S. Army's Pohakuloa Training Area (PTA) (Figure 1) is a 44,100 ha installation located in the saddle region between Mauna Kea and Mauna Loa on the island of Hawaii. Approximately one-half of the installation is ordnance impact area, and the remaining lands are used for maneuver training by the Army's 25th Infantry Division (Light), Marine's 1st Expeditionary Brigade, National Guard, Army Reserves, and occasionally by allied troops. Shaw *et al.* (1990) reported that approximately 4% of the installation outside of the impact area has been disturbed by military training. Most of the installation has not been impacted by military activities because rugged terrain makes much of the area inaccessible. Major disturbances which result in greatly reduced vegetative ground cover are typically limited to undeveloped roads, frequently used bivouac sites, and fixed artillery firing points.

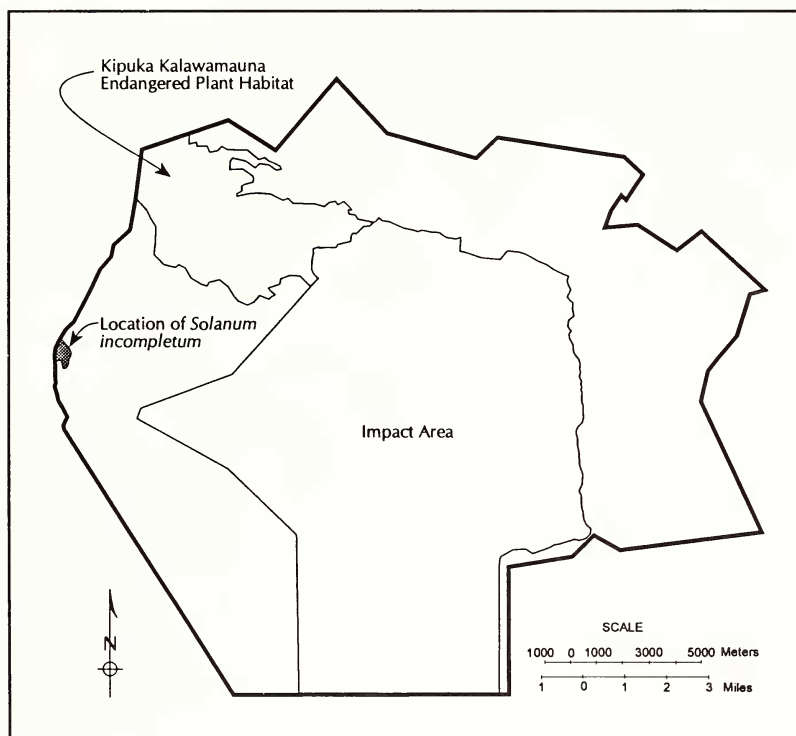


Figure 1. U.S. Army's Pohakuloa Training Area, Hawaii, Hawaii with large ordnance impact area, endangered plants habitat, and location of "rediscovery" site of *Solanum incompletum* Dunal.

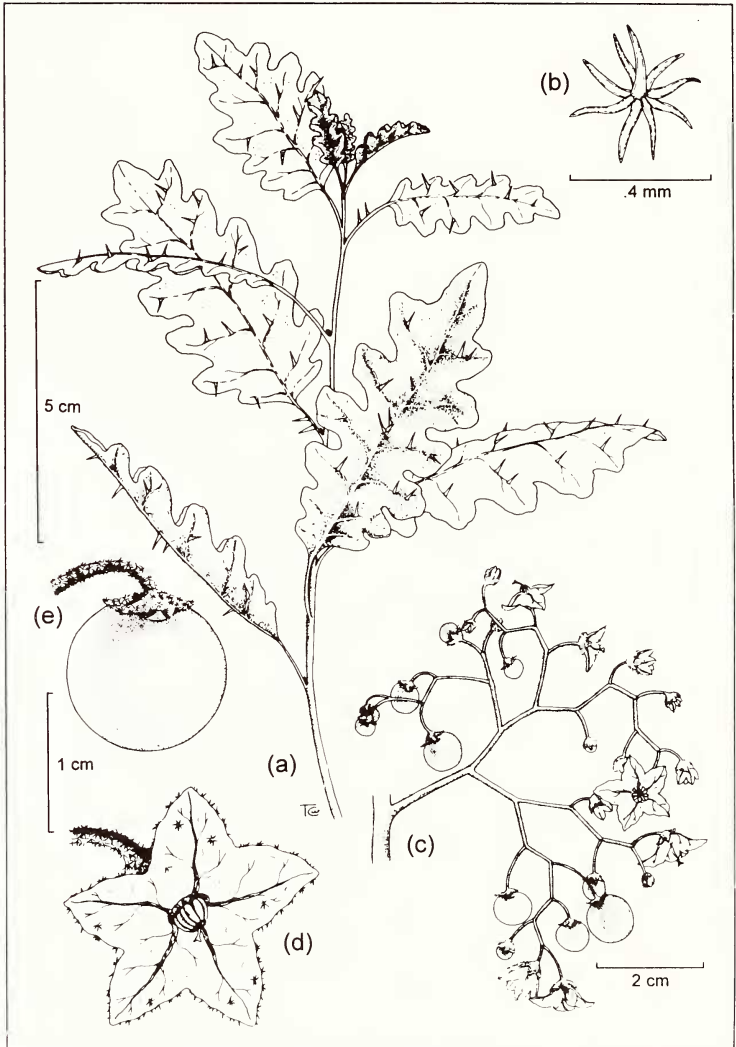


Figure 2. Line drawing of *Solanum incompletum* Dunal. a. habit, b. stellate hair, c. inflorescence, d. flower, e. fruit [(a & b from C.N. Forbes *ns*, Kona, Hawaii, 23 June 1923 (BISH); c & e from J.F. Rock *ns*, Puu Ikaaka, Hawaii, Feb 1912 (BISH), d from G.C. Munro *ns*, Kaiholena, Lanai, 30 March 1919 (BISH)].

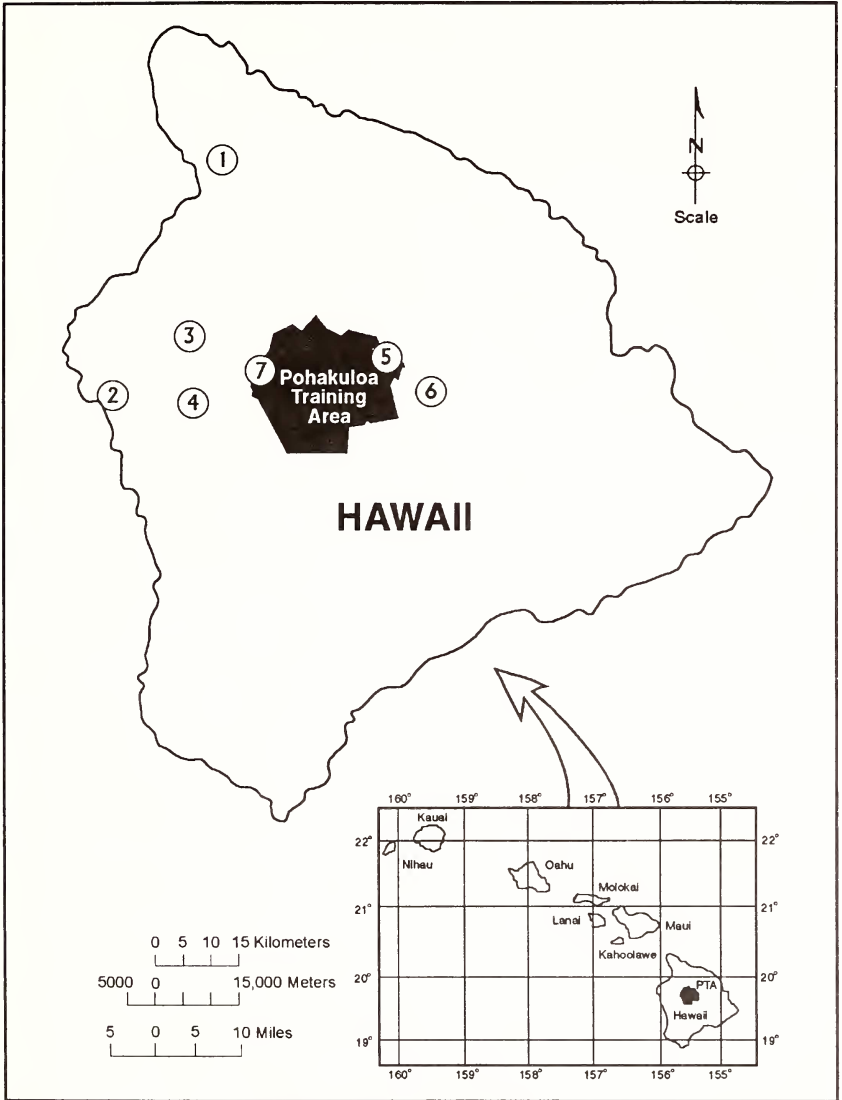


Figure 3. Reported locations of *Solanum incompletum* Dunal. on the island of Hawaii: (1) Kawaihae, (2) Kona, (3) Puu Waawaa, (4) Puu Ikaaka, (5) Puu Omaokaii, (6) Puu Huluhulu and (7) new site at Pohakuloa Training Area.



Figure 4. Photograph of *Solanum incompletum* Dunal in vegetative stage on the U.S. Army's Pohakuloa Training Area, Hawaii, Hawaii.



Figure 5. Photograph of *Myoporum* shrubland on approximately 5000 year old Mauna Loa Pahoehoe lava flow which is typical of the area where *Solanum incompletum* was found on the U.S. Army's Pohakuloa Training Area, Hawaii, Hawaii.

Castillo *et al.* (1995) described and mapped 24 plant communities on the installation and identified four major associations. First, barren lava and disturbed areas with little or no ground cover compose about 12,475 ha. Second, treelands dominated by *Metrosideros polymorpha* Gaud., *Chamaesyce olowaluana* (Sherff) Croizat & Degener, and *Myoporum sandwicense* A. Gray constitute nearly 14,300 ha of the installation. Third, shrublands comprise 15,700 ha and have the greatest diversity of communities. Dominant shrubs are *Myoporum sandwicense*, *Sophora chrysophylla* (Salisb.) Seem., *Styphelia tameiameia* (Cham. & Schlechtend.) F.v. Muell., *Dodonaea viscosa* Jacq., and *Chenopodium oahuense* (Meyen) Aellen. Fourth, native (*Eragrostis atropioides* Hillebr.) and introduced [*Pennisetum setaceum* (Forssk.) Chiov.] grasslands make up the remaining 1625 ha. Some of the largest relatively undisturbed, dry montane treelands, shrublands, and grasslands found on the island of Hawaii occur in the saddle region including PTA (Gagne & Cuddihy 1990; Tierney *et al.* 1996).

Shaw & Douglas (1996) listed over 250 taxa from 70 families and 175 genera of vascular plants from the installation. As floristic surveys and vegetative studies continue, species not previously reported from the installation are continually collected, verified, and added to the species list. Numerous rare plant species have been reported from the installation. Federally listed endangered species verified from the installation are: *Asplenium fragile* C. Presl. var. *insulare* Morton (Bruegmann *et al.* 1994), *Haplostachys haplostachya* (A. Gray) St. John (Herbst & Fay 1979), *Hedyotis coriacea* Sm. (Herbst *et al.* 1992a), *Portulaca sclerocarpa* A. Gray (Mehrhoff 1994), *Silene lanceolata* A. Gray (Herbst *et al.* 1992b), *Spermolepis hawaiiensis* Wolff (Canfield *et al.* 1994; J. Lau, pers. comm.), *Stenogyne angustifolia* A. Gray (Herbst & Fay 1979), *Tetramolopium arenarium* (A. Gray) Hillebr. (Douglas *et al.* 1989; Mehrhoff 1994), and *Zanthoxylum hawaiiense* Hillebr. (Mehrhoff 1994). The Kipuka Kalawamauna endangered plants habitat area (Figure 1) was cooperatively designated by the U.S. Army, U.S. Fish & Wildlife Service, and State of Hawaii Division of Land and Natural Resources primarily for the protection of the first two endangered species found on PTA (*H. haplostachya* and *S. angustifolia*). One federally listed threatened species, *Silene hawaiiensis* Sherff (Mehrhoff 1994), occurs on PTA. *Neraudia ovata* recently was verified from the installation and has been proposed as an endangered species (Bruegmann 1995). The following taxa from PTA are considered species of special concern: *Chamaesyce olowaluana*, *Eragrostis deflexa* Hitchc., *Exocarpos gaudichaudii* A. DC, *Festuca hawaiiensis* Hitchc., *Hesperocnide sandwicensis* (Wedd.) Wedd., *Portulaca villosa* Cham., *Tetramolopium consanguineum* (A. Gray) Hillebr., and *T. humile* (A. Gray) Sherff subsp. *humile* var. *sublaeve* Sherff. Specimens from PTA once reported as *T. lepidotum* (Less.) Sherff are being described as a new species (T. Lowrey, pers. comm.).

The purposes of this paper are to: (1) report the "rediscovery" of the endangered species *Solanum incompletum* Dunal (Canfield *et al.* 1994), (2) document its occurrence on PTA and (3) delineate current and/or potential threats to this endangered species.

Solanum incompletum is reported to be a shrub to 3 m in height (Symon 1990). In the PTA populations, the plant appears to be suckering from the base after being browsed by feral ungulates; thus, it appears suffrutescent and only slightly woody. St. John (1969) also reported that *S. incompletum* suckers and has strong vegetative shoots. There are a few dead stems 5 to 7 dm in height remaining on a single

individual. The plants are armed with stout reddish prickles nearly 5 mm in length, and they occur on both surfaces of the leaves and on the stem (at least on new growth) (Figure 2). The leaves are simple, alternate, and elliptical with variously lobed margins. In the plants at PTA, prickles occur on the petioles, mid-rib and prominent lateral veins on both leaf surfaces. Leaf venation, particularly on the undersurface, is prominent. Also, new growth is pubescent with prominent yellowish stellate hairs. Symon (1990) reported, and examination of herbarium material shows, that the species has perfect, regular-shaped flowers borne in simple to compound cymes. None of the plants we observed in the field were in flower or fruit. Symon (1990) described the fruit as a berry which probably is yellow and ripens to black. He suggested that the fruit may not be produced often and that plants and/or flowers may be self-incompatible. We observed, however, young seedlings with long linear cotyledons germinating in proximity to adult plants.

Hillebrand (1888) distinguished two varieties. *Solanum incompletum* var. *mauiense* Hillebr. was segregated based on larger leaves, while *S. i.* var. *glabratum* Hillebr. was separated because the mature leaves were glabrate. Also, St. John (1969) named a separate but related species (*S. haleakalaense* St. John) from Maui based on leaf shape and abundance of prickles. In the latest treatment of the Solanaceae of Hawaii, however, Symon (1990) placed *S. haleakalaense* in synonymy and did not recognize any subspecific taxa because of incomplete collections and taxonomic difficulties with the genus (Canfield *et al.* 1994).

Solanum incompletum was first collected on Hawaii by Nelson in 1779 and has subsequently been found on Kauai, Molokai, Lanai, and Maui (St. John 1978; Symon 1990). On the island of Hawaii, the species was known from Kohala Mountains, Kona, Puu Waawaa, Puu Ikaaka, Puu Omaokoili (on PTA), and Puu Huluhulu (Canfield *et al.* 1994) (Figure 3). The last reported sighting of this species was from Puu Huluhulu where two individuals were found forty-five years ago growing at 2040 m in an *Acacia koa* A. Gray and *Sophora chrysophylla* mesic forest (Canfield *et al.* 1994). The PTA locations lie between Puu Waawaa and Puu Omaokoili/Puu Huluhulu (Figure 3). Symon (1990) described the elevational range of *S. incompletum* from 300 m to 2040 m. Historical habitats varied from dry mesic forest to diverse mesic forest and finally to subalpine forests.

Solanum incompletum was "rediscovered" on PTA on 19 January 1996 by Close & Schnell. Nine adult individuals are growing at the base of several *Myoporum sandwicense* shrubs. The *S. incompletum* plants have from one to three stems per individual, but when first seen were only 3 dm or less in height because of browsing by feral sheep and goats. As previously mentioned, the plants appear much more herbaceous than shrubby (Figure 4). Also, two germinating seedlings, identified by the characteristic red prickles, are establishing under *M. sandwicense* and indicate that viable seeds must have been produced at some time.

The *Solanum incompletum* individuals occur in a kipuka (*i.e.*, older usually vegetated flow surrounded by younger less vegetated flows forming pockets or islands of vegetation) which supports a *Myoporum* shrubland at an elevation of approximately 1425 m (Figure 5). The shrubland is on a relatively old [5000 years before present (ybp)] Mauna Loa pahoehoe lava flow which subsequently was surrounded by younger Mauna Loa aa flows (4200 ybp). Multi- or occasionally single-stemmed *Myoporum sandwicense* shrubs averaging about 3 m in height dominate the site.

Other woody species in the immediate area are *Myrsine lanaiensis* Hillebr. and *Sophora chrysophylla*. The understory is dominated by "weedy" alien species and indicative of areas over utilized by feral ungulates. Numerous trails, animal droppings, wool or hair entangled in branches, and bones from dead animals all indicate heavy use of the area by feral sheep and goats. Associated understory species include *Solanum pseudocapsicum* L., *Marrubium vulgare* L., *Pennisetum setaceum*, *Asclepias physocarpa* (E. Meyer) Schlecter, and *Kalanchoe tubiflora* (Harv.) Raym.-Hamet.

Canfield *et al.* (1994) discussed threats to *Solanum incompletum* at the time it was listed as endangered. They indicated that the major threats were: (1) reduced number of individuals and populations which increases the potential for extinction from stochastic events; (2) correlated with the first threat is over-utilization for commercial, recreational, scientific, or educational purposes because of low numbers; and (3) competition from the alien plant species *Senecio mikanioides* Otto *ex* Walp. at Puu Huluhulu. They did not indicate that feral animals were a threat because the only known extant population at the time of listing was already fenced to protect the area.

On PTA browsing by feral animals represents an immediate threat to the continued existence of the species at this location. Although the plant is covered with prickles, feral sheep and/or goats appear to relish it. The area in which the population occurs should be immediately fenced to protect the species; or at the very least, individual plants should be caged in order to allow them to flower and potentially produce viable seeds for propagation. Threats to *Solanum incompletum* by military training at PTA are almost non-existent. Accessibility to the area is very difficult and easily controlled. There are no roads within the area, thus dust from military vehicles does not represent a threat. The possibility of accidental fire from military ordnance, obscourants, etc. is remote because the species occurs approximately 5 km from the nearest boundary of the ordnance impact area.

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